

3. The Divided Eyes of Arthropoda.

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In the current number of the *Zeitschrift für wissenschaftliche Zoologie* (Bd. 63. Heft 2) Dr. Carl Zimmer under the title »Die Facettenaugen der Ephemeriden«, p. 236—262, plates XII—XIII describes the intimate structure of the divided eyes of the males of *Chloe* and certain other genera of *Ephemeridae*. While it has long been known that certain *Ephemeridae* and other insects possess two pairs of compound eyes, or one pair in which each eye has facets of two sizes grouped in two fields separated by a more or less distinct line or constriction, the differences in finer structure between the members of each pair of these divided eyes, or between the eye-elements of the two regions of the quasi-divided eyes are first made known in Zimmer's paper. Chun¹ has described the divided eyes of *Stylocheiron* and certain other genera of pelagic Crustacea, and has explained the necessary physiological difference of these morphologically different optic fields. He offers also an explanation for the occurrence of the two kinds of eyes among these marine Crustacea.

In a recent study of the anatomy of *Blepharocera capitata* (a Nematoceros Dipteron from North America) I have found a similar differentiated condition of the compound eyes of both males and females. Each compound eye has facets of two sizes grouped in two distinct regions. By means of sections it is readily discernible that the ommatidia, or eye-elements of these two regions differ markedly. Those of the region of larger facets, which is the upper and hinder part of the eye, are conspicuously longer, larger and fewer in number than those in the region of smaller facets, which is the frontal part of the eye. In addition while the frontal region is strongly pigmented, the region of larger ommatidia is very scantily pigmented. Without offering here a detailed account of the structure of the eye-elements of the two regions it is sufficient to say that the differences in structure are essentially those which distinguish an eye specially adapted for the perception of moving objects from an eye of the more normal type. The special characters of the large-facetted region of the eye of *Blepharocera* agree in the general tendency and character of their differentiation from the normal type with the large-facetted eyes of the pelagic Crustacea (Chun) and the male *Ephemeridae* (Zimmer). In the males of *Chloe* and in several pelagic Crustacea the variant eyes are fully adapted for the production of »Superpositions-bilder«, a condition not reached in *Blepharocera*.

¹ Chun, Carl, Atlantis, Biologische Studien über pelagische Organismen, in Bibliotheca Zoologica. Bd. 7. Heft 19, 1896.

The presence of two kinds of faceted eyes in pelagic Crustacea, the males of *Ephemeridae*, and males and females of *Blepharocera* (certain other Nematocerous Diptera, as *Simulium*) show also the two sizes of facets and possess probably the corresponding structural differences in eye-elements), and the general correspondence of the morphologic characters of the differences between the two sorts of eyes in these three widely separated groups of Arthropoda offer an interesting subject of attention. In the case of the Crustacea the Dunkelaugen enable the animal to see its prey (for the crustacea possessing these divided eyes are all predaceous) in the poorly lighted water levels below the surface. The large faceted eyes of the males of *Chloe* are also true »Dunkelaugen«, and serve the insects (according to Zimmer's explanation) for perceiving the females during the twilight marriage flights characteristic of the genus. The large-faceted eyes of the males of other genera of *Ephemeridae* are not true »Dunkelaugen« but are a less differentiated sort adapted especially for the perception of moving objects. They enable the males to recognize the dancing females. In the case of *Blepharocera* the large-faceted eye-regions probably serve for the perception of moving prey. The females of *Blepharocera* are dimorphic and one form only possesses divided eyes, this form having mouth parts (with piercing mandibles) adapted for blood-sucking, while the other form with only the normal small-faceted eyes has no mandibles and is nectar-feeding. The males have also piercing mandibles and are blood-sucking (unusual among Diptera), and have, as already noted, divided eyes. In other words the predaceous males and females of *Blepharocera* have faceted eyes of two kinds while the nectar-feeding females have only the usual small-faceted, strongly-pigmented eyes.

There is necessary a study of other insects with divided eyes before a satisfactory explanation of this peculiar condition is possible. While in the case of the pelagic Crustacea and of the males of *Chloe* the necessity of perceiving moving objects by twilight or in dimly lighted water, affords a probable explanation of the extreme differentiation of the eye-elements, the lesser differentiation shown in the case of the other *Ephemeridae* and of *Blepharocera* apparently depends on the need of the recognition of moving objects in the light, in one case for the discovery of the females during the mating flight, in the other for the discovery of the flying prey.

It seems that the Arthropod eye is enabled to overcome to some extent the disadvantages incident to its usual or normal structural condition by a differentiation of the eye-elements. By this differentiation there is made possible a certain adaptability of the vision to varying conditions of focus and intensity of light.